WHAT IS CLAIMED IS:

1. An exposure apparatus for exposing a pattern onto a semiconductor wafer, comprising:

an illumination system having an illumination source emitting a beam and an illumination optical assembly guiding the beam onto the pattern;

a lens assembly projecting the beam passed through the pattern onto the wafer held by a wafer table; and

a positioning device comprising:

a housing;

a piezoelectric actuator having a first and second end, the first end fixedly mounted to the housing and the second end movable in a first direction in response to a change in voltage applied to the piezoelectric actuator; and

a structure for moving the wafer table in a second direction in response to the second end of the piezoelectric actuator moving in the first direction comprising:

a first joint movable in the first direction in response to the second end of the piezoelectric actuator moving in the first direction;

a second joint movable in the second direction to move the wafer table in the second direction;

a diagonal member connected to the first and second joints at an angle with respect to the first direction; and

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a flexure connecting the diagonal member to the first joint, the flexure bendable in response to the first joint moving in the first direction to change the angle with respect to the first direction and thereby move the second joint in the second direction.

2. The exposure apparatus of claim 1, wherein the flexure connecting the diagonal member to the first joint is a first flexure and the structure further comprises a second flexure connecting the diagonal member to the second joint, the second flexure bendable in response to the first joint moving in the first direction to maintain the movement of the second joint in the second direction.

3. The exposure apparatus of claim 2, wherein the diagonal member connected to the first and second joints is a first diagonal member, the angle with respect to the first direction is a first angle, and the structure further comprises:

a base fixedly mounted to the housing;

a second diagonal member connected to the first joint and the base at a second angle with respect to the first direction;

a third flexure connecting the second diagonal member to the first joint; and

a fourth flexure connecting the second diagonal member to the base,

wherein the third and fourth flexures are bendable in response to the first joint moving in the first direction to change the second angle with respect to the first direction and thereby move the first and second joints in the second direction.

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4. The exposure apparatus of claim 3, wherein the structure further comprises:

a flange holding the second end of the piezoelectric actuator and movable in the first direction, the flange having an axis parallel to the first direction;

an axial member connected to the flange and the first joint;

a fifth flexure connecting the axial member to the first joint; and

a sixth flexure connecting the axial member to the flange,

wherein the fifth and sixth flexures are bendable in response to the first joint moving in the second direction to maintain the axis of the flange parallel to the first direction.

5. The exposure apparatus of claim 4, wherein the exposure apparatus includes a first, second, third, and fourth positioning device to control the position of the wafer table in four degrees of freedom.

6. The exposure apparatus of claim 5, further comprising a wafer stage movable to the position of the wafer table in x and y directions, the four positioning devices being mounted to the wafer stage such that the four positioning devices cooperate to control the position of the wafer table in z direction, around an x-axis, around a y-axis, and around a z-axis.

7. The exposure apparatus of claim 6, wherein the first positioning device is mounted to a first side surface of the wafer stage and the second, third, and fourth

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positioning devices are mounted to a second side surface of the wafer stage opposite to the first side surface.

8. The exposure apparatus of claim 6, wherein the second joint of the first positioning device moves in the z direction to control the position of the wafer table around the x-axis.

9. The exposure apparatus of claim 6, wherein the second joint of the third positioning device moves in the z direction to control the position of the wafer table around the y-axis.

10. The exposure apparatus of claim 6, wherein each second joint of the first, second, third positioning devices moves simultaneously in the z direction to control the position of the wafer table in the z-direction.

11. The exposure apparatus of claim 6, wherein each of the first, second, and third positioning devices further comprises a block fixedly mounted to the housing, the block having an opening for the second joint to move in the second direction therethrough.

12. The exposure apparatus of claim 11, wherein each of the first, second, and third positioning devices further comprises a guide flexure having a hole, the guide flexure fixedly mounted to the block so that a projection formed on the second joint moves in the second direction through the hole.

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13. The exposure apparatus of claim 12, wherein each of the first, second, and third positioning devices further comprises a universal flexure having a first end portion connected to the projection on the second joint and a second end portion connected to the wafer table.

14. The exposure apparatus of claim 13, wherein the universal flexure further includes a mid portion and two flex members connecting the mid portion to the first and second end portions.

15. The exposure apparatus of claim 13, wherein each of the second and third positioning devices includes a flexure strip having a flexing portion formed between two slits, the flexing portion including a hole formed therein for the second end portion of the universal flexure to pass therethrough to connect to the wafer table.

16. The exposure apparatus of claim 15, wherein the flexure strip includes side portions disposed outside the flexing portion to support the wafer table.

17. The exposure apparatus of claim 6, wherein the second joint of the fourth positioning device controls the position of the wafer table around the z-axis.

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18. The exposure apparatus of claim 17, wherein the wafer stage includes a first and second bar, and a flexure plate extending from the first bar toward the second bar and held at a first position.

19. The exposure apparatus of claim 18, wherein the second, third, and fourth positioning devices share a common housing connected to the flexure plate.

20. The exposure apparatus of claim 19, wherein the common housing includes a third bar fixedly mounted thereto, the third bar having an edge connected to the second bar to form a hinge.

21. The exposure apparatus of claim 20, wherein the flexure plate bends from the first position to rotate the common housing around the hinge as a result of a change in a pushing force exerted on the second side surface of the wafer stage by the second joint of the fourth positioning device.

22. The exposure apparatus of claim 4, wherein the flange of the structure includes a recess holding the second end of the piezoelectric actuator.

23. The exposure apparatus of claim 4, wherein the structure includes a pair of the first diagonal members.

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24. The exposure apparatus of claim 23, wherein the structure includes a pair of the second diagonal members.

25. The exposure apparatus of claim 4, wherein the second direction is perpendicular to the first direction.

26. The exposure apparatus of claim 4, wherein the first and second angles are equal.

27. The exposure apparatus of claim 4, wherein the first and second angles are about 45 degrees.

28. The exposure apparatus of claim 27, wherein the first and second angles change less than 1 degree in response to the first joint moving in the first direction.

29. The exposure apparatus of claim 4, wherein ratio of the movement of the first joint in the first direction to the movement of the second joint in the second direction is about 1 to 2.

30. The exposure apparatus of claim 29, wherein the movement of the second joint in the second direction is less than 200 microns.

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31. The exposure apparatus of claim 4, wherein the illumination source produces an electron beam.

32. The exposure apparatus of claim 31, wherein the structure is fabricated from a nonmetallic material.

33. The exposure apparatus of claim 32, wherein the nonmetallic material is Zirconia ceramic.

34. The exposure apparatus of claim 32, wherein the nonmetallic material is Alumina ceramic.

35. A device for positioning a wafer table, comprising:

a housing;

a piezoelectric actuator having a first and second end, the first end fixedly mounted to the housing and the second end movable in a first direction in response to a change in voltage applied to the piezoelectric actuator; and

a structure for moving the wafer table in a second direction in response to the second end of the piezoelectric actuator moving in the first direction, comprising:

a first joint movable in the first direction in response to the second end of the piezoelectric actuator moving in the first direction;

a second joint movable in the second direction to move the table in the second direction;

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a diagonal member connected to the first and second joints at an angle with respect to the first direction; and

a flexure connecting the diagonal member to the first joint, the flexure bendable in response to the first joint moving in the first direction to change the angle with respect to the first direction and thereby move the second joint in the second direction.

36. The device of claim 35, wherein the flexure connecting the diagonal member to the first joint is a first flexure and the structure further comprises a second flexure connecting the diagonal member to the second joint, the second flexure bendable in response to the first joint moving in the first direction to maintain the movement of the second joint in the second direction.

37. The device of claim 36, wherein the diagonal member connected to the first and second joints is a first diagonal member, the angle with respect to the first direction is a first angle, and the structure further comprises:

a base fixedly mounted to the housing;

a second diagonal member connected to the first joint and the base at a second angle with respect to the first direction;

a third flexure connecting the second diagonal member to the first joint; and

a fourth flexure connecting the second diagonal member to the base,

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wherein the third and fourth flexures are bendable in response to the first joint moving in the first direction to change the second angle with respect to the first direction and thereby move the first and second joints in the second direction.

38. The device of claim 37, wherein the structure further comprises:

a flange holding the second end of the piezoelectric actuator and movable in the first direction, the flange having an axis parallel to the first direction;

an axial member connected to the flange and the first joint;

a fifth flexure connecting the axial member to the first joint; and

a sixth flexure connecting the axial member to the flange,

wherein the fifth and sixth flexures are bendable in response to the first joint moving in the second direction to maintain the axis of the flange parallel to the first direction.

39. The device of claim 38, further comprising a block fixedly mounted to the housing, the block having an opening for the second joint to move in the second direction therethrough.

40. The device of claim 39, further comprising a guide flexure having a hole, the guide flexure fixedly mounted to the block so that a projection formed on the second joint moves in the second direction through the hole.

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41. The device of claim 40, further comprising a universal flexure having a first end portion connected to the projection on the second joint and a second end portion connectable to the table.

42. The device of claim 41, wherein the structure, the guide flexure, and the universal flexure are fabricated from a nonmetallic material.

43. The device of claim 42, wherein the nonmetallic material is Zirconia ceramic.

44. The device of claim 42, wherein the nonmetallic material is Alumina ceramic.

45. The device of claim 41, wherein the universal flexure further includes a mid portion and two flex members connecting the mid portion to the first and second end portions.

46. The device of claim 41, further comprising a flexure strip having a flexing portion formed between two slits, the flexing portion including a hole formed therein for the second end portion of the universal flexure to pass therethrough to connect to the table.

47. The device according to claim 46, wherein the flexure strip includes side portions disposed outside the flexing portion configured to support the table.

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48. The device of claim 38, wherein the flange of the structure includes a recess holding the second end of the piezoelectric actuator.

49. The device of claim 38, wherein the structure includes a pair of the first diagonal members.

50. The device of claim 49, wherein the structure includes a pair of the second diagonal members.

51. The device of claim 38, wherein the second direction is perpendicular to the first direction.

52. The device of claim 38, wherein the first and second angles are equal.

53. The device of claim 38, wherein the first and second angles are about 45 degrees.

54. The device of claim 53, wherein the first and second angles change less than 1 degree in response to the first joint moving in the first direction.

55. The device of claim 38, wherein ratio of the movement of the first joint in the first direction to the movement of the second joint in the second direction is about 1 to 2.

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56. The device of claim 55, wherein the movement of the second joint in the second direction is less than 200 microns.

57. A structure for moving a wafer table, comprising:

a first joint movable in a first direction;

a second joint movable in a second direction to move the wafer table in the second direction;

a diagonal member connected to the first and second joints at an angle with respect to the first direction; and

a flexure connecting the diagonal member to the first joint, the flexure bendable in response to the first joint moving in the first direction to change the angle with respect to the first direction and thereby move the second joint in the second direction.

58. The structure of claim 57, wherein the flexure connecting the diagonal member to the first joint is a first flexure and the structure further comprises a second flexure connecting the diagonal member to the second joint, the second flexure bendable in response to the first joint moving in the first direction to maintain the movement of the second joint in the second direction.

59. The structure of claim 58, wherein the diagonal member connected to the first and second joints is a first diagonal member, the angle with respect to the first direction is a first angle, and the structure further comprises:

a fixedly mountable base;

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a second diagonal members connected to the first joint and the base at a second angle with respect to the first direction;

a third flexure connecting the second diagonal member to the first joint; and

a fourth flexure connecting the second diagonal member to the base,

wherein the third and fourth flexure are bendable in response to the first joint moving in the first direction to change the second angle with respect to the first direction and thereby move the first and second joints in the second direction.

60. The structure of claim 59, further comprising:

a flange movable in the first direction and having an axis parallel to the first direction;

an axial member connected to the flange and the first joint;

a fifth flexure connecting the axial member to the first joint; and

a sixth flexure connecting the axial member to the flange,

wherein the fifth and sixth flexures are bendable in response to the first joint moving in the second direction to maintain the axis of the flange parallel to the first direction.

61. The structure of claim 60, wherein the flange includes a recess configured to hold a piezoelectric actuator designed to move the flange in the first direction.

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62. The structure of claim 60, wherein a pair of the first diagonal members are connected to the first and second joints.

63. The structure of claim 62, wherein a pair of the second diagonal members are connected to the first joint and the base.

64. The structure of claim 60, wherein the second direction is perpendicular to the first direction.

65. The structure of claim 60, wherein the first and second angles are equal.

66. The structure of claim 60, wherein the first and second angles are less than 45 degrees.

67. The structure of claim 66, wherein the first and second angles change less than 1 degree in response to the first joint moving in the first direction.

68. The structure of claim 60, wherein ratio of the movement of the first joint in the first direction to the movement of the second joint in the second direction is about 1 to 2.

69. The structure of claim 68, wherein the movement of the second joint in the second direction is less than 200 microns.

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70. The structure of claim 60, wherein the structure is fabricated from a nonmetallic material.

71. The structure of claim 70, wherein the nonmetallic material is Zirconia ceramic.

72. The structure of claim 70, wherein the nonmetallic material is Alumina ceramic.

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